

XXXI.—*Regeneration of the Tarsus and of the Two Anterior Pairs of Limbs in the Orthoptera saltatoria.* By EDMOND BORDAGE*.

I.—IT would be useless to try and provoke self-mutilation of the first two pairs of limbs in the *Orthoptera saltatoria*. By giving, however, a strong pull to the legs, they may be separated from the body. Such separation rarely takes place at the joint between the femur and trochanter †, but much more often at that between the latter and the coxa. The injury thus inflicted upon the insect is generally fatal; the muscles break irregularly, making a ragged tuft, while bleeding is copious. When the Orthopteron survives, if it still be in the larval state, regeneration can act and produce either a perfect limb when separation has taken place at the joint between femur and trochanter, or a more or less rudimentary stump when the trochanter has been severed from the coxa.

These facts seem in a twofold manner to invalidate the law of Lessona:—1stly, because there is regeneration at points where mutilations do not appear to be normally produced; 2ndly, because regenerations at the two places are most frequent in the one where pulling more rarely leads to the separation of the limb, and because they are without any comparison more complete in the same region.

If we notice what happens during the changes of skin, we shall see that this double paradox breaks down before an examination of the normal facts.

In point of fact, it is by no means rare during moulting for one of the limbs to be detached from the body by *exuvial self-mutilation*. Contrary to what we found before, separation takes place almost always at the joint between the femur and the trochanter, and very rarely at that between the latter and the coxa. In the first of these cases bleeding is comparatively insignificant, while in the second it may be fatal. Mutilation in such a way is much less severe and less frequently followed by death than if it had been produced experimentally. The power of regeneration often acts in the first case, and may sometimes produce a perfect limb ‡. When

* Translated from 'Comptes Rendus,' cxxix. (July 17, 1899) pp. 169–171, by Wilfred Mark Webb, F.L.S. From a separate impression communicated by the Author.

† It is impossible sometimes even to separate it at this point by pulling. In *Gryllus campestris*, for instance, I have to make use of scissors to effect the removal.

‡ Among the *Orthoptera saltatoria* the parts in process of regeneration grow slowly, from which the experimenter may be at first tempted to believe that such regeneration does not exist. Also a reproduced limb

regeneration occurs in the second case, a jointless stump is formed hardly 2 or 3 millim. in length. The facts described explain themselves completely.

On the other hand, however, it may seem inexplicable that exuvial self-mutilation should show itself in the case of limbs which it appears *à priori* ought to experience no difficulty in withdrawing from their old chitinous covering, such limbs being of sufficiently restricted dimensions. I should, however, call attention to the fact that among the Arthropoda when moulting there is not a single appendage (leg, antenna, palp), however modest its dimensions may be, in which there may not at the particular moment happen to be accidental adhesions between the new chitinous covering and the old. The Arthropod which cannot when moulting overcome these difficulties is infallibly doomed to die. This furnishes the explanation why in moulting Arthropoda there ought to be but very few appendages in which one cannot find traces of more or less marked exuvial self-mutilation *, either complete or partial, and at the same time of regenerative power. It may even sometimes be possible to discover regeneration in certain parts belonging to limbs specially modified for quite particular functions. This is the case with the tarsi of the preying-legs of the Mantidæ and those of the digging-legs in the mole-crickets. Further mutilation of these limbs would end in death either indirectly or after a brief delay and by bleeding.

II.—In the *Orthoptera saltatoria* regeneration of the tarsi in the three pairs of limbs takes place with ease; this is to be expected, seeing that the tarsi are frequently damaged as a result of the struggles made by the insect to free itself when moulting. It is particularly well marked in the elongated tarsi of the jumping-legs. Regeneration here takes place even after artificial cuts removing the tarsus, and even a little piece of the terminal portion of the tibia, which is reproduced as well. The presence of the regenerative power in the last-mentioned region is easily explained when it is taken into consideration that its muscular fibres are often damaged when the tarsus is torn off either during moulting or, more rarely, by the unsuccessful attack of some natural enemy.

III.—In *Phylloptera laurifolia* and *Conocephalus differens* regeneration gives a tetramerous tarsus (tetramery is the rule

never reaches the length of the corresponding one that remains in place, and it is often incapable of rendering any real service. It is probably this slowness of growth that led Graber to conclude too hastily that regeneration of the tarsus did not take place.

* The greater perfection of exuvial self-mutilation is properly directed to the difficulties which appendages, owing to their shape or size, experience in disengaging themselves from their old chitinous coat.

in Locustidæ). In *Gryllus capensis* regenerated tarsi still show three joints, but the new tarsus in this case is in some respects more massive than the normal one. The third joint is nearly equal to the first, while in the normal tarsus it is considerably longer than the latter. Finally, the second joint, which in the ordinary tarsus is very small and almost entirely hidden, is quite visible in the regenerated one. This difference is particularly noticeable in the case of the posterior limbs*.

So far as the nature of the tarsal regenerations is concerned in *Acridium rubellum* I cannot at present speak, my experiments with this species not being yet completed †.

BIBLIOGRAPHICAL NOTICE.

Die Fledermäuse des Berliner Museums für Naturkunde.—Neunzig, unter Leitung von Prof. W. Peters und Paul Matschie, gezeichnet und lithographirte Tafeln. Bearbeitet und durch Verbreitungskarten und Bestimmungstabellen für alle bekannten Arten ergänzt. Von PAUL MATSCHIE, Kustos am Museum für Naturkunde zu Berlin. Berlin: Georg Reimer.

Erste Lieferung. Megachiroptera. Pp. 103, pls. i.–xiv., 1899. 24 Marks.

For many years every student of the Chiroptera has known of, and hoped for the publication of, the magnificent series of plates to illustrate this group of animals drawn by the famous draughtsman J. D. L. Franz Wagner under the direction of the late Prof. Peters. A foretaste of their quality was given by the publication of a few of them in illustration of some of Prof. Peters's papers, but otherwise, although many of them are now more than 30 years old, no one had been able to see them except at Berlin or at Genoa, to whose Museum Prof. Peters had given a set.

Now at last an instalment of them is published in illustration of a general work on Bats by Dr. Paul Matschie, accompanied by further plates drawn by that author's deceased wife.

This work will be of the greatest utility to all students of Bats, and abounds with evidences of the author's care and of the richness of the materials on which it is based. Synoptical tables are given of all the genera, subgenera, and species; and although some of those we have tried have not quite responded to the call made upon them, yet they give a most useful index to the characters mainly relied upon by the author in distinguishing the various forms.

* It should be stated that the regenerated tarsus represents one of the organic positions of stability intermediate between the actual normal form and an ancestral one.

† In Locustidæ and Gryllidæ the tibia of regenerated anterior limbs does not possess the *tympanic* apparatus which exists on the original limb.